General Science Quarterly

Vol. II. JANUARY, 1918 No. 2

Science in the War.[1]

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These are crucial times in which we are now living. The world has been at war for about three and one-half years. Lord Northcliffe during the last seven months while in this country spent $127 per second, counting all the seconds day and night, for supplies in the interest of the allies. The U. S. in the short space of three months has built 16 cities of 40,000 population in each, has appropriated over 700 million dollars for the building of aircraft, and made numerous other appropriations on the same scale. Mr. Vanderlip calls our attention to the fact that the total expenditures of our government from its foundation, including that of the Civil War, has been only 26 billion dollars as compared with the 19 billion which we are proposing to spend this year alone.

Germany is pushing on in an effort to realize on a contract in which she has bartered her soul in an expectation of gaining the world.

Twenty-one nations of the world have declared war on Germany and have banded themselves together to defeat this monstrous German propaganda.

In a conflict such as this, every means of production and destruction known to man is being used.

Science in the last fifty years has made some wonderful advances. Its aim has been the amelioration of man. To make the work of men more effective. To take the burden off the backs of men and have it carried by natural agencies. To give men more time to devote to matters of spirit so that his plane of life might be higher. Germany is now forcing the world to divert all these great discoveries and inventions to the art of destruction.

Since the beginning of the war, the effort and application of scientists has been very intense. The subjects "Science in the

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[1]Paper given before the Physics Section of the Central Association of Science and Mathematics Teachers, at Columbus, Nov. 30, 1917.

War" or "The Effect of War on Science" would be equally interesting and would lead along the same lines of thought. Many things which scientists have been striving to attain have by intense and cooperative effort been pushed ahead thrice as fast as they would have been in times of peace.

We had gasoline motors before the war, but now we have Liberty Motors. This is the product of patriotic men who have pooled their brains and knowledge of motors in the production of one motor which contains all the good points of all the motors.

We had flying machines before the war, but they were slow. To ascend to a height of a mile or so required considerable time,—30 minutes or more. The requirements now for much of the service is a height of 15,000 feet or more in 10 or 15 minutes. Requirements are constantly changing. If we had made up a lot of flying machines three years ago, few of them would be of any use at the front. We could to great advantage have prepared ourselves to meet the demand for raw material such as iron, coal, copper, etc., also such finished products as cars, locomotives, and ships, but it would not have been wise then to put up a lot of finished machines of the kind which science and invention has rapidly changed to meet changing conditions.

We also had motor trucks before the war. Many different kinds of them. They saved France at the battle of the Marne. At that time they were glad to get any kind of truck but it required about 2,000,000 parts to keep them in repair. The solution of this difficulty has been worked out in America where 12 of the best men from motor truck plants and 62 from parts plants met in Washington a short time ago and dumped their trade secrets on the table. Ordinarily in such a meeting each would have been careful to keep to himself any good point which his company had discovered for his machine, but here all was laid on the altar of patriotism and the result is the Liberty Truck, initial orders for 10,000 of which are now placed with 60 different factories. That is the kind of backing most of our manufacturers are giving to this war.

Of course in a time such as this a great many impractical and foolish schemes are brought forward. It is reported that 40,000 different propositions have been sent in to Washington for combating the submarines and doing many other wonderful stunts. These for the most part are from those who have had neither experience nor scientific training,—those who insist on education

being "practical" to the exclusion of fundamental principles. One scheme that lately attracted considerable attention is the use of so called "free energy," whatever that may mean, by a man named Giragossian. By this it is possible to propel air ships and submarines and locomotives around the earth several times without taking on fuel by the way. It solves the whole problem of gasoline and coal shortage and in fact puts to shame all scientific efforts of the past. The claims for the Keely motor hoax in its day were very modest compared with this. It seems rather ridiculous that a committee of Congress would seriously consider a claim of this kind and make a recommendation to Congress, as has been done, that the matter be investigated. Of course a scientist should have an open mind but it should not have to be open very long in propositions of this kind. Such things admonish all of us who are teachers of science to insist more strongly on the great principles of conservation and correlation of energy.

In contrast with this we may mention, as a real and productive, scientific inquiry, the construction at Washington, by proper scientific authority, of a huge receiver of an air pump. It is made of cement, is air tight, large enough to receive the working parts of a flying machine, provided with a refrigeration outfit, and other apparatus necessary to make the test. The purpose is to try out the operation of the machine at a height, say, of 16,000 feet where the air is rare and the temperature low. Thus it is hoped to find answers to such questions as: What style of carburetor is best for these rapidly changing conditions? Will aluminum and other metals retain their tensile strength and other properties when the temperature changes. Will the varnish with which the linen of the wings are filled retain its earth-surface qualities? Thus the conditions of operation in the upper air can be supplied and the necessary material and means of adjustment can be provided. Painstaking work of this kind is where real progress in science is made.

Most of the operations in this war are applications of physics and chemistry. Some of the wars of the past might be called a blacksmith's war, for they fought with spears and swords which were hammered out in the smithy. A battle now, however, is often a conflict of scientifically constructed machines.

Take, for example, the operation of a flying machine. To begin with, there is action and reaction. The propeller drives air in one

direction and in doing so drives the machine in the opposite direction. Then if the machine is tilted up a little in front, a vertical component of force lifts it from the ground and holds it there as long as the machine is in motion. The aeronaut has with him a barometer by which he can tell how high he is. He carries with him, possibly, a Gatling gun and must know how to operate this. He may want to shoot forward in the direction he is moving but there is his propeller and he must not splinter those wooden blades, so that although the blades are moving so fast that he can see only a hazy circle where the propeller is turning yet the synchronizing device with which his rapid firing gun may be provided will send the bullets between and will not hit the blades.

The flier must also know something about photography for it is by this means that a great deal of information is obtained in regard to enemy positions, trenches, movements, etc. That is what is meant by putting out the enemy's eyes. Our feverish production of air machines at this time has for one of its purposes the mastery of the air so that the enemy may not be able to hover over us, take photographs of our lines, or direct the aim of their artillery.

The dropping of bombs from air planes involves a strict application of Newton's first and second laws of motion, the application of which in this work is an art very difficult to attain. If the plane is moving horizontally at the rate of 100 miles per hour, and at a height of 16,000 feet, then, from $s=\frac{1}{2}gt^2$, a bomb let fall would reach the earth in about 30 seconds. During this time the bomb will continue its horizontal motion of 100 miles per hour. If, then, it is dropped when the plane is directly over a building, it would miss the mark by considerably more than three-quarters of a mile.

Then, too, the flier must be provided with a wireless outfit for both sending and receiving, particularly sending, for he can thus give his army warning of impending movements which they cannot see and the gunners must rely on him to tell them when their missiles go beyond, fall short, or go to either side. Often the roar of machinery drowns out sounds of the message he is to receive and so many machines are provided with delicate string galvanometers and, looking through glasses he can read the dots and dashes by the movement of the string.

Beside all this, the flier must know something about astronomy

and the stars for up there it is easy to be lost and the stars at night may help him on his way.

A young man who prepares himself for such work as this, who is sufficiently sound in heart, eye, ear, lungs and brain, and who can go through the grilling experience of a battle in the clouds, certainly deserves at least our highest admiration. We are told in the press of a young man who recently strolled into a New York hotel and wrote on the register the name W. A. Bishop. He did not have an imposing appearance for he is short and weighs about 100 lbs., but it was soon found out that this was Maj. Wm. Avery Bishop who has had bestowed on him every decoration which the British have provided for this kind of service. He has to his credit 110 combats in the air in which he sent 47 enemy machines hurtling to the earth and put 23 others out of commission. He was just then on his way to Toronto to be married and has since been giving help in the aviation fields of this country.

Of course it must be understood in the description given above that there are a variety of styles of machines and that they are equipped in different ways for the different kinds of service which they are to perform.

Principles of physics are also directly applied in artillery practice. The range finder is a delicate optical instrument. The range of the projectile can be calculated from the angle of elevation and the initial velocity, and the height of ascent is found from the same data, also the time of flight, this last being of especial importance in case of shrapnel shells that the fuse may be properly set.

Of course everybody regrets the enormous destruction that must accompany a war of this kind. Destruction of art, property, and life as well as the cessation of that production which would have taken place during the time the war lasts. But even war is not without its compensations. If a result of this war shall be, as we surely think it will be, that the world will be a better place to live in for all time to come, then the nations will be requited for the sacrifice they are now making.

A nation or an individual can often do more in a single year under the spur of a pressing need or a great motive than they would do during several years under ordinary conditions. This is particularly true if that nation has grown rich and has yielded to the allurements of ease and luxury.

The U. S. since the war began, particularly since last April, has been looking itself over as never before. It has been giving itself a severe cross-examination and taking an inventory of its stock and its ways of doing things. This is very desirable at any time but it is seldom done except in times of great stress. A few examples will illustrate this fact. One large establishment has just discovered that they used no corks in their red-ink bottles and the ink has been evaporating, the waste in this amounting to several hundred dollars per year. Another has discovered that they have been extravagant in the use of rubber bands and are now making the necessary retrenchment. In the scarcity of coal, emphatic attention is being directed to hydro-electric plants. The use of electric locomotives on the C. M. & St. Paul R. R. in crossing the Rocky Mountains is saving thousands of tons of coal and oil each year. The power comes from the Great Falls of Montana. Not only is this great amount of fuel saved but each electric locomotive is equal in hauling power to three ordinary ones. These then are released for other work.

Before the war there were only five factories engaged in making dyestuff in this country and their output was small. Now we have 100 such companies which produce not only all the dyes needed here but export more than we formerly imported. Germany has had a monopoly in the dye industry because she managed to make us believe it was her secret, and she is able under her political system to exploit her labor at home and undersell anything we might produce. It is hoped that after the war Germany may be put on the same producing basis as ourselves or that our congress will see the wisdom of keeping this industry at home. Our chemists are eminently able to produce the dyes.

Again, we are finding ourselves short of potash. A German authority said that our going into the war was like a man putting a noose about his neck and allowing them, the Germans, to hold the other end of the rope, for they, he said, had a monopoly of potash and so could dictate what nations should starve and which might have food. So we have been looking about and find that we have various sources of this important ingredient of the soil. The dust from our cement mills and the kelp, sea weeds, growing beneath the water on the Pacific coast will furnish a considerable quantity and chemists tell us that Searles lake in California contains in solution

20,000,000 tons of potash. Our importation from Germany before the war was about one-half million tons per year, and so the potash in this lake would at this rate keep us supplied for about 40 years.

The nitrates also are indispensable in the manufacture of munitions and in fertilizers. The nitrate beds in Chili are nearing exhaustion and the war is forcing the U. S. to look about for new sources of this chemical. Years ago when the great hydro-electric plant at Niagara was started, an attempt was made to form a company for the fixation of atmospheric nitrogen. Capital could not be interested however, and so nothing was done in this country. The Norwegians and Germans copied the proposed process with success. In 1916 the du Pont powder company offered to make a contract with our government and furnish all the capital needed to establish a large plant for the fixation of atmospheric nitrogen, the governmen to permit the use of water power. This was not done. If it had been done we would now be well on our way in the production of all the nitric acid and nitrates we need. We are slow in giving the proper encouragement or subsidies to science in its early stages and to far-seeing men and corporations who make a close study of conditions. Ericsson received no help from our government until after the Monitor had defeated the Merrimac. It is hoped that one effect of this war will be that all of us will have a more liberal attitude in this respect. Congress has lately appropriated under the pressure of war necessity, 20,000,000 dollars for the fixation of atmospheric nitrogen either by the electric arc process or by some other method which a committee of scientific men will recommend.

Any stimulation of the production of potash or the nitrates will assist not only in winning the war but will be very useful afterward in increasing the productivity of the land.

Science makes this war different from all other wars not only in the machines and chemicals used but also in the care of the man. Reports show that about 90% of those who are wounded recover and 40% of them return to the lines. Immediate antiseptic applications and irrigation of deep wounds are in no small degree the cause of this gratifying result.

Deaths from sickness in the army, also, are less than in peace times. This is brought about in two ways. First, sanitary conditions are enforced by men who know what real sanitation is and

thus germs of disease are for the most part avoided. Second, the bodies of soldiers are fortified against disease before they go into service. A soldier is not asked whether or not he wishes to be vaccinated, he is simply vaccinated. Likewise he is fortified against typhoid. There is also an anti-gangrene serum which will further improve matters in this regard.

This is in marked contrast with conditions during the Civil War where more men died from sickness in the camp than were killed in battle.

Of course in a conflict such as this, many must die. It is difficult to find a satisfactory compensation for this, but while the most cherished principles of America and other free nations are at stake, we must be willing to make the sacrifice or go down in history as a nation of cowards. As Secretary Lane has lately said, "It is more precious that America should live than that we Americans should live".

The enthusiastic response of our people to all the appeals of President Wilson gives full assurance that the United States will do her duty.

Science in Modern Warfare.[1]

BY L. L. EDGAR.

The Great War has been called a "grand physical phenomenon" and a "battle of the sciences." To the layman this does not mean very much, but it is nevertheless a fact. It could just as well be called a "chemist's war" or an "engineer's war" or a "surgeon's war," so much have the various sciences contributed toward carrying on the war. Most of us do not think of the part science has played in this great struggle. All we see and read of is the terrible fighting and wastage of human lives. It is very interesting to go into the subject deeper and see what has made possible all this fighting, and just where science and its application has to do with modern trench warfare.

Every known science has played an important role, including chemistry, physics, hygiene, mathematics, engineering, geography, geology, metallurgy, geodesy, bacteriology, meteorology, astronomy,

1From November, "Edison Life."

and many more of the physical and natural sciences. The war has demonstrated two things: first, that warfare cannot be carried on without the necessary raw materials, that is chemical, physical and metallurgical supplies; and secondly, it cannot do without the organization of the different scientific elements in connection with the military establishments.

The discovery that such an organization was necessary to the maintenance of war was of prime importance, and it has become essential that each man in a country at war be assigned a task to which he is fitted. At the beginning of the war, the civilians and their advice were not seriously considered by the military authorities. To-day one cannot tell whether the next officer he meets was a soldier before the war or a professor of science in some college. Productive brains receive more care and protection now than any other part of the population.

Let us take some of the more important sciences and see what connection they have in waging war. The astronomer has become an important factor in preparing artillery tables and maps and in perfecting instruments. The statistician is very valuable in planning an offensive, as is also the meteorologist. When trenches are dug, the geologist is consulted, as he can tell the best places for shelter, and the probability of striking underground waters. The leader of the war in France, in the person of the minister of war, is a mathematician, and his personal staff are of the same profession.

The science of acoustics, about which, up to the beginning of the war, very little was known, has blossomed out into that of the greatest importance. The French have in use several systems of determining by acoustics the position of enemy batteries. It is possible by these systems to tell to within a few yards the position of a gun fifteen miles away, to determine its caliber, to tell the difference between the discharge, the flight through the air, and the bursting. The spot from which a shell was fired has been found before the shell landed and exploded. A battery of French thirteen-inch cannon, mounted on a railway truck, fired four shots at an invisible target over fifteen miles away. By means of "sound ranging" and photographs taken the day before from an airplane, the cannon were sighted correctly and the four shots demolished

an enemy battery. Photographs taken after the fourth shot proved it was destroyed. This is only one example of what goes on every day at the front. Just think for a minute what such a feat means. First, an exact knowledge of the region must be known by means of maps. The preparation of these maps is a stupendous task in itself, involving triangulation from various points and photographs from airplanes and balloons. Next, the characteristics of the enemies' cannon must be obtained and their exact positions in relation to their own battery. After each shot the huge cannon must be put back into position. This is done by finely adjusted optical instruments. Then certain correction must be made, due to differences in the weight of the shells, the weight, age, and quality of the charge of powder, and the age, temperature, and state of erosion of the guns. The atmospheric conditions, such as direction, and force of the wind at different heights, the temperature, pressure and humidity of the air all produce disturbances, which must be taken into account and corrected. All this entails an exact knowledge of many of the sciences. In addition to these the shell must explode at the proper instant and must have a proper "fragmentation." All this means exact application of science.

Acoustics are also used in mining operations, in locating airplanes at night, and in submarine detection.

Photography has also been carried to a very advanced stage. Nearly all successful offensives are dependent on correct maps and ranges, and the taking and correct interpretation of aerial photographs has become a military necessity. The French Army have many schools where the training of observers is carried on, teaching the art of taking photos and making maps from them.

Electricity of course has had many applications in warfare, the most important of which is the wireless. Tens of thousands of portable outfits have been made to supply the armies. The success of wireless has been due to the prevention of interference and sorting out of the messages from among the great mass of signals, for during a battle it is a common occurrence for more than fifteen hundred separate stations to send messages simultaneously.

In chemistry, the application has been in asphyxiating gases and tear-producing gases, and of course in the making of gunpowder.

In France alone there are over twenty-five different laboratories engaged in research work on nitrogen fixation.

The weather man, who is not considered to those facetiously inclined very reliable over in the United States, plays an important part. He knows when a gas attack may be expected; he helps the artillery in giving corrections for wind pressures and temperatures; he tells the aviators what winds to expect and their strength; he advises the balloon man; he tells the transports when to expect muddy roads, and the headquarters when to look for rain and fog, and if his information is incorrect a large and well planned attack may be a failure.

In aviation, the remarkable advances during the past few years have been due to the research work carried on in the numerous establishments erected for that purpose.

In addition to the foregoing there are the sciences of medicine, sanitation and surgery. The advances in these have been wonderful. Trench warfare alone has been a new science, bringing with it its employment of scientific research. The supply of munition and maintaining their quality and standard is vital to success. Nothing is so disastrous to an army as premature explosions of its shells.

These examples may give our readers a slight insight into the tremendous magnitude, enormous scope, and far-reaching extent of the problems of modern warfare from the viewpoint of science.

The object lesson to be learned from all this is that for a successful termination of this war, all these sciences and their application, or, in other words, the organizations back of these sciences, must become a harmonious whole, a perfect blending of the many complex and intricate parts with the sole purpose of destroying the enemy. This unity of purpose is the most striking impression received by watching the armies of the Allies.

General Science in Amherst Junior High School.

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The significant aim of a course in practical science is to acquaint both girls and boys with many of the commonplace experiences of life that are continually transpiring and toward which only a sight-seeing attitude is generally taken. There is a lack of appreciation of the simple mechanical processes and the fundamental phenomena of the universe due to the continuing stress on professional, business, and commercial aims in our schools. If there is evidence of stress in the practical direction at the present time, practicality has smothered the situation. It is provincial as it relates itself to the trade schools. The spectacular career of the vocational school, and its work is proving invaluable, has absorbed our attention. In a rational way now practical training must be given to every girl and boy as well as the few who elect to specialize in it. It must be simple because it is; 1st, fundamental and general, 2nd, no attempt at specialization.

Equipments—The equipment of the manual training room, and the simplest science laboratory equipment, in short a duplication of ordinary conditions will enhance the true value of these lessons. A small cabinet of instruments and tools which may be carried from room to room is economical and desirable. A good text constitutes a good guide to logical procedure and is to be recommended.

Significant Results:—A thoroughly practical, though simple understanding of science involving simple mechanics, physics, chemistry, botany, forestry, geology, astronomy, cookery, and home work is an important contribution to knowledge. Other study will unconsciously be turned into more scientific channels if the pupil handles materials and makes observation of the world as it is. At the same time this kind of science will be a valuable sub-aid to the understanding of all subject matter, and the further realization of what the world really does will stimulate other school activities. We want our girls and boys to have this knowledge of science and

we frankly want them to have a certain degree of skill in elementary handiness which heretofore has been lamentably neglected in public school instruction. Manual training in the form of woodworking is here included. We should aim in the junior high school for a very general course in science. No specific phase of science has enough latitude.

Methods:—With a good text in hand and a systematic outline provided thereby, only general directions become necessary. It is a commonplace, but nowhere more applicable, that the teacher should be profoundly interested in the subject. It would be a serious check to the significant aim of general science if the pupil was not taught that its prime importance lies in the procedure he adopts and the attitude he takes toward any work whatever. A careless habit is not scientific. This is not a book subject and consequently much supplementing with exercises involving tests of observation is necessary. A resourceful teacher will provide a variety of work to demonstrate a wide application of the principles.

THE FOLLOWING IS A TWO-YEAR COURSE.

Outline for Girls.

In all science work, conditions actually surrounding the pupils are considered first. One general aim is to acquaint the pupil with her everyday environment and to awaken her to a life of activities that will always present some opportunity for seeing something new and interesting.

Special Aims:

1. To have pupils appreciate nature and to wish to ask questions about natural objects and phenomena.
2. To have pupils acquire a knowledge of facts by experience that will help in their understanding of the natural laws acquired by later study.
3. To help pupils understand their home environment and be interested in conserving home life in all forms.
4. To have pupils acquire a certain minimum of information which will help them to understand other subjects better.
5. To show pupils what improvements can be made in their own homes and the community.

PART I.

HOUSEHOLD SCIENCE.

I. Dust
- a. Composition (Living) (Lifeless)
- b. Object of dusting
- c. Directions for removing
- d. Dust in its relation to the choice of house furnishings.

II. Water
- a. Water as a solvent
  1. impurities (organic, inorganic)
  2. scource of impurities
  3. effect of impurities on the use of water
- b. Characteristics of:
  1. spring water
  2. well water
  3. river water
- c. How to purify water
  1. distilling
  2. filtering
  3. boiling
- d. Effect of heat upon water
- e. Hard water
  1. action of soap
  2. temporarily hard waters
  3. permanently hard waters
- f. Means of softening

III. Artificial aids to cleanliness.
- a. Mechanical agents
  Commercial
  1. Kinds suitable to use in cleaning unfinished wood
  2. Cleaning steel, agate, zinc
  3. Cleaning aluminum
  4. Cleaning brass, copper
  5. Cleaning porcelain
  6. Cleaning silver, gold
- b. Chemical agents in
  1. alkalies
  2. absorbers
  3. solvents

IV. Removal of stains.
- a. Effect of chemicals upon animal and vegetable fibers
- b. Use of acids and alkalies
- c. Effect of washing upon stains
- d. Best time

V. Disposal of waste.
- a. Care of ashes and rubbish
- b. Care of garbage
  1. care of garbage can
  2. cleaning of garbage can
- c. Care of food in the house
  1. storage of perishable food in the refrigerator
  2. storage of fruits and vegetables
  3. storage of groceries
- d. Relations to household pests; harms, cause, prevention, remedy.
  1. flies, mosquitoes, roaches, ants, moths, mice

VI. Sanitation of the house.
- a. Location
- b. Drainage
- c. Foundation
- d. Construction plans
- e. Plumbing

VII. Sanitation as applied to heating.
- a. How air is affected by burning wood, etc., in it.
- b. Fuels: source, composition, fuel value.
  1. wood, 2. charcoal, 3. peat, 4. gas, 5. coal, 6. oil

VIII. Sanitation as applied to lighting.
- a. Candles
  1. history of making candles
- b. Burning of a candle.
  1. necessary elements for burning
  2. explanations of smoke arising after candle has been extinguished.
- c. Burning and care of a kerosene lamp.
  1. the wick and its absorption of kerosene
  2. gas formed before it burns
  3. connection currents and their necessity
  4. control of draft
  5. construction of burner

6. danger from lamp explosion and how avoided

d. Gas: (coal gas and water gas)
   1. substances from which gas may be manufactured
   2. harmful effect of gas and its cause

e. Electricity.
   1. advantages of electric lighting over other means of artificial lighting
   2. fixtures
   3. indirect lighting

IX. Examination of a coal range.
   a. Fire-box, lining, grate, ash-pan
   b. Dampers
      1. main, front damper, check dampers, oven dampers, and chimney dampers
   c. Explain the direction and cause of drafts
   d. Draw an illustration of these drafts.
   e. How to build a fire
      1. combustible materials
      2. arrangement of materials
      3. draft
      4. adjustment of dampers
      5. care needed if kerosene is used

X. The gas range and its management.
   a. Become acquainted with the following parts:
      1. top burners and their regulating cocks
      2. oven burners and their regulating cocks
      3. baking-oven burners and their regulating cocks
      4. broiling oven
      5. oven lighter or "pilot light"

XI. Kerosene stove.
   a. Different types
   b. Care
   c. Management

XII. Home decoration.
   a. Selections of wall coloring to give warm or cool impression
   b. Wall decoration
   c. Arrangement of pictures
   d. Arrangement and selection of rugs
   e. How to brighten a dark room

f. Emphasize the amount and kind of furniture
g. Appropriate furniture for 1. kitchen, 2. dining-room, 3. living-room, 4. bedroom
h. Arrangement of furniture
i. Putting in original "touches"
j. The use of flowers in the house—also on dining table

PART II.

NATURAL SCIENCE.

Natural science may be taught in connection with home garden work. Urge all who are able to care for home gardens. Teach pupils to plan ahead exactly what they wish to work with and then have them carry out their plans accordingly.

In this work photographs of garden plots, trees, flowers, etc., are a great inspiration and help.

I. Diagram of plot of ground showing location of house (if near) and location, shape and size of garden.
  a. Draw to a scale
  b. Aim for original ideas.

II. Plan for flower bed.
  a. Diagram each row exactly
  b. Use one end as a measuring basis

  When planning the flower bed, care must be given to the following features:
  1. Time of blooming
  2. Size of plant
  3. Color of flowers
  4. Amount of foliage
  5. Conditions necessary for best growth

III. Plan for vegetable garden
  a. Diagram of each row or hill
  b. Use one end as a measuring basis.

  In planting vegetables the pupil must have in mind later conditions rather than appearance while growing although the latter must be also considered.

Pupils should make an attempt to plant hardy vegetables at first and care for a few well. The last column gives the distance between rows.

PLANTING SEEDS—FLOWERS.

Plants	*Depth*	*In Row*	*Rows*
Ageratum	¼ in.	6 in.	1 ft.
Alyssum, sweet	½ in.	6 in.	1 ft.
Aster	⅛ in.	¾ in.	1 ft.
Bachelor's Button	¼ in.	6 in.	1 ft.
Balsam	½ in.	1 ft.	1 ft.
Calendula	½ in.	6 in.	1 ft.
Candytuft	¼ in.	6 in.	1 ft.
Carnation	¼ in.	6 in.	1 ft.
Castor Bean	1 in.	4 ft.	4 ft.
Crysanthemum	⅛ in.	¾ ft.	1 ft.
Coboea	½ in.	1½ ft.	along fence
Cosmos	¼ in.	1½ ft.	2 ft.
Cypress Vine	¼ in.	6 in.	along fence
Dianthus	¼ in.	6 in.	1 ft.
Forget Me Not	¼ in.	6 in.	1 ft.
Geraniums, etc.	Plants	1 ft.	1½ ft.
Hollyhock	½ in.	1½ ft.	2 ft.
Hop (Humulus)	¼ in.	1½ ft.	along fence
Kochia (for foliage)	½ in.	2 ft.	1 ft.
Larkspur	¼ in.	1—1½ ft.	1½ ft.
Marigold	¼ in.	1—1½ ft.	1½ ft.
Mignonette	¼ in.	6 in.	1 ft.
Morning Glory, dwf.	½ in.	6 in.	1 ft.
Morning Glory, tall	1 in.	6 in.	along fence
Nasturtium	1 in.	1 ft.	along fence
Pansy	⅛ in.	6 in.	1 ft.
Petunia	⅛ in.	¾ ft.	1 ft.
Phlox	⅛ in.	6 in.	1 ft.
Poppy	⅛ in.	6 in.	1 ft.
Portulaca	¼ in.	6 in.	1 ft.
Salpiglossis	1-16 in.	6 in.	1 ft.
Salvia	¼ in.	1½ ft.	2 ft.
Snapdragon	⅛ in.	6 in.	1 ft.
Stocks	¼ in.	6 in.	1 ft.
Sunflower	½ in.	2 ft.	3 ft.
Sweet Peas	2 in.	6 in.	3 ft.
Sweet Sultan	¼ in.	6 in.	1 ft.
Zinnia	¼ in.	6 in.	1 ft.

PLANTING SEEDS—VEGETABLES.

Proper depth of furrows (usually about four times thickness of seed) in first column; distances apart of plants in row outdoors in second column; distance between rows in third column.

Plant usually 2 or 3 seeds (more if small) near where a single plant is to stand; thin out, when they crowd, to one at each place.

Plants	*Depth*	*In Row*	*Rows*
Beans, bush	1 in.	6 in.	2 ft.
Beans, pole	1 in.	2-3 ft.	3 ft.
Beets	1 in.	4 in.	1 ft.
Cabbage	½ in.	2-3 ft.	2½—3 ft.
Carrots	½ in.	4 in.	1 ft.
Corn	1 in.	6 in.	3 ft.
Kohlrabi	½ in.	½ ft.	1½ ft.
Lettuce, Curled	¼ in.	2 in.	1 ft.
Lettuce, Head	¼ in.	6 in.	1 ft.
Onion Seed	½ in.	4 in.	1 ft.
Onion Sets	1 in.	4 in.	1 ft.
Parsley	¼ in.	6 in.	1 ft.
Parsnips	½ in.	6 in.	1 ft.
Peas	2 in.	6 in.	3 ft.
Potato (tubers)	4 in.	1 ft.	3 ft.
Radish	½ in.	2 in.	3 ft.
Spinach	½ in.	2 in.	1 ft.
Swiss Chard	1 in.	4 in.	1 ft.
Tomato	½ in.	3 ft.	2½—3 ft.
Turnips	½ in.	6 in.	1½ ft.

Cucumbers, 6 or 8 seeds, ½ in. deep to be thinned to 2 or 3 plants, at places.

Muskmelon, Summer Squash, 4 ft. apart.

Pumpkin, Squash, 6 or 8 seeds, 1 in. deep, to be thinned to 2 or 3 plants, at places 6 or 8 ft. apart.

IV. Seeds appropriate for a beginner's garden.

V. Study of seeds and seedlings
- a. Directions for sprouting
- b. Study and compare the seeds and seedlings of the beans, peas, and corn.
- c. Observe and compare other sprouting seeds
- d. Observe the seeds while sprouting and "coming up" and

compare the young plants (seedlings) with what is found in the soaked seeds. Draw the different stages.

1. Try to find from what part of the seed each part of the seedling comes.
2. What parts do seedlings have?
3. Which parts of this little plant do you find ready made in the seed?
    a. The first leaves
    b. The first stem (caulicle)
    c. A part ready to grow the opposite direction and make more stem and leaves (plumule)

Because of the short summer season it is often necessary to start seeds indoors in order to have them mature before fall. Window boxes are good for this work if no hot-house conveniences are possibie. Methods of transplanting should be carefully studied so that the plant of seedling will not die when placed out-doors.

The use of cold frames for bulbs in the fall should also be discussed.

VI. Study of parts of mature plant
- a. Roots
    1. Use to plant: a. furnish food materials; b. hold plants in place
- b. The Stem
    1. General description
    2. Use
- c. Leaves
    1. Use
        - a. furnish food materials (carbon dioxide)
        - b. description
        - c. time of growth
- d. Flowers
    1. Purpose
    2. Essential parts
        - a. stamens; anthers; filament
        - b. pistil; stigma; style; ovary
        - c. coralla 1. description 2. purpose
        - d. calyx
- e. Fruit
    1. Purpose
    2. How developed

In studying the parts of a flower, different kinds should be examined. The purpose of this is to study fertilization of one flower by another and the different ways in which this is done. Try to get plants which have two distinctly different blossoms e. g. the squash blossom has the staminate blossoms and the pistillate blossoms. The fern is also interesting in its method of reproduction having spores and also root sprouts.

The use of the different parts of the plant should also be emphasized. In some plants we use the root for food e. g. carrots, turnips, etc. In others we use the stem e. g., celery. In others we use the leaves, e. g. lettuce, cabbage, etc. In others we use the blossom e. g. cauliflower. In others we use the buds e. g., herbs for tea and certain kinds of flowers.

VII. Use of plants to man
- a. Food
- b. Beauty
- c. Increase fertility of soil
- d. Purify air
- e. Moderate temperature 1. transpiration 2. shade
- f. Regulate moisture
  1. preserve moisture
  2. prevent evaporation
  3. prevent erosion and so sustain vegetation
  4. regulate stream flow
  5. keep rivers navigable
- g. Fuel
- h. Shelter

VIII. Some objectionable forms of plant life
- a. Weeds
  1. Nature's way of propagation
- b. Poisonous plants
- c. Those which take food materials from necessary plants.

IX. Other enemies of plants
- a. Pests
  1. caterpillars. 2, tomato worm. 3, cut worm. 4, squash bug. 5, potato beetle. 6, rose bug. 7, aphis. 8, elm beetle. 9, brown tailed moth. 10, gypsy moth. 11, borers. 12, codling moth, etc.
- b. Extermination of these
  1. spraying with poison

2. destroying their eggs
3. preserving their natural enemies, which are helpful to man.
   a. almost all birds. b, lady bug. c, frogs. d, dragon flies

The extermination of plant enemies is vital, the pupils must know the manner in which they harm the plant, therefore encourage the pupils to search for these pests or to find traces of their destruction. For example, the work of the potato beetle is commonly known. The cut worm can be found quite frequently and the plant lice, or aphis, are also seen frequently. All these have different methods of working ruin and until these methods are understood, the pupils' attempt at helping the plant will be futile.

Emphasize the fact that one of the best ways to exterminate the enemies of plants is to preserve their natural enemies.

X. Trees
   a. Kinds
      1. Deciduous—trees which lose their leaves in the fall
         a. maple; b, elm; c, oak; d, poplar; e, birch; f, ash
      2. Conifers—trees which do not change appearance during the year.
         a, pine; b, spruce; c, hemlock; d, cedar; e, fir

Different trees have various ways of building. Some have strong end buds while others have strong lateral buds. Let the pupils learn this by examining tree twigs.

Other interesting facts, such as the age of trees, the structure, the grain, etc., should also be taken up.

   b. Enemies
      1. fire. 2, insects. 3, pavements. 4, carelessness of man
   c. Uses
      1. in native state. 2, in manufacturing. 3, in building
   d. Substitutes
      1, metal. 2, cement. 3, composition

PART III.

Astronomy.

Astronomy as studied in the eighth and ninth grades should be a review of planetary geography. This included interesting facts about the sun and its relation to the earth, a slight study of different constellations for recognition, the cause of eclipses, tides, and winds.

I. Comparative age of the earth.
  a. Comparison between different mountain ranges.
  b. Reason given for the variation in age.
  c. Description of the formation of the earth and moon.

II. Relation of the earth to the sun.
  a. Earth's orbit
  b. The seasons as caused by the sun.
  c. Summer and winter
    1. The movement of the earth explains the change of temperature in the different zones.
    2. Corresponding seasons in tropic and frigid zones.
  d. The motions of the earth. (Explanation of day and night.)
  e. The zones.
    1. Tropic—hottest because it receives the vertical rays of the sun
    2. Temperature receives slanting rays of sun;—it is less hot.
    3. Frigid receives very oblique rays of the sun:—it is the coldest.
    4. Explanation of equator and heat equator.

III. The moon.
  a. Cause of different moons.
  b. Movement of moon around the earth.
  c. Physical features of the moon.
  d. Eclipse of Sun.

IV. The planets.
  a. Give a general description of the other bodies moving around the sun.
  b. Learn names of them and be able to recognize them as they appear in the sky.

V. Stars.
  a. Physical nature of stars.
  b. Their source of light and its appearance to us.

VI. Meteors.
  a. Observe shooting stars.
  b. Tell about meteors that people have found. Halley's comet.

VII. Constellations.
  a. Be able to locate and recognize the following constellations.

1, the big dipper; 2, the little dipper; 3, the North star; 4, Orion; 5, Milky way

PART IV.

PHYSICAL GEOGRAPHY.

I. Atmospheric pressure.
- a. Definition
- b. Measurement of
  - 1. Use of barometer
- c. Variation with altitude
- d. Effect of pressure on air volume.

II. Winds.
- a. Caused by unequal pressure
- b. Effect on temperature
- c. The velocity of wind
- d. Direction of wind
- e. Meaning of a "High"
  - 1. Causes rise in barometer
  - 2. Means fair weather
- f. Meaning of a "Low"
  - 1. Causes fall in barometer
  - 2. Means stormy weather
- g. The path of "highs" and "lows"
- h. The deflection of winds in the Northern Hemisphere
- i. The general wind system and its prevailing type of weather.
  - 1. Equatorial calms, or doldrums
    - a. hot and moist
    - b. heavy showers
  - 2. Trades
    a, steady; b, showers occur on islands and windward coasts; c, hurricanes; d, cyclones; e, typhoons; f, baguios
  - 3. Prevailing westerlies
    - a. unequal temperature
    - b. highs and lows
  - 4. Polar winds
- j. Land and sea breezes
- k. Monsoons of India.

Outline for Boys.

Special Aims:

1. To inculcate the habit of observation and scientific procedure.
2. To show how this applies to such subjects as mathematics, English, etc.
3. To perform a few exhaustive experiments of varied kinds to show the application. Treatment of the elements, water, air, and fire, will be valuable both for the information and for the exercise. A few actual repair jobs will be necessary in order to teach handiness effectively.
4. To create a desire to be handy-about-the-house.
5. A real science lesson will be more than a exercise—it will have a justifiable object.

I. Scientific Procedure.

II. Study of matter.
   a. The material
   b. The immaterial
   c. Liquids, solids, gases

III. Suggestive outlines.

Note:—The following outlines are offered as suggestions for boys' science. It is assumed that a text will furnish a more specific outline and it is also assumed that local problems relating to industry, commerce, and agriculture will vary.

A. WATER.

Introduction:—Water should be recognized in its different states—liquid, solid, gaseous. It is one of the sustaining elements of the universe and upon the other elements—earth, air, and fire—acts for the preservation of mankind. In what everyday ways do earth, air and fire utilize water for man's benefit? In what ways do they combine for his existence? The teacher will be able to give a very interesting demonstration by showing chemically the properties of water.

It is important to study the phases of power dependent on water, the sources of water supply, and the urgent necessity of conserving our forests to this end.

Do not fail to emphasize the reasons for public economy and cooperation in safe-guarding municipal reservoirs.

Simple classroom demonstrations to show physical actions of water are necessary to fix in the pupils' minds such actions as the siphon, hydraulic ram, gravity supply, and water vacuum.

Outline:

1. Life necessity
2. Sources
3. Evaporation:
   a, sun; b, wind; c, stagnation
4. Condensation:
   a, clouds; b, rainfall; c, fog
5. Purification:
   a, boiling; b, distillation; c, filtration
6. Solvent properties:
   a, rocks; b, minerals; c, crosion
7. Physical properties:
   a, weight; b, boiling point; c, freezing; d, liquid (water); solid (ice); gas (steam).
8. Civic systems
   a, wells,—excavated, driven, artesian; b, ponds; c, reservoirs; d, pumping station; e, high and low pressure; f, pumps, siphon, hydraulic ram
9. Meter:
   a, principle; b, reading

B. HEAT.

Introduction:—Much useful information, incidental to the subject, should precede the technical subject matter. Pupils are most familiar with the heat generated by fire and the sun. The fire in the house receives comparatively little scientific attention. Teach the economy of clean fires in the range, and furnace, clean smoke pipes, the necessity of fresh air to easy and economical heating, the causes of asphyxiation, the care of heating plants when the fires are out, the cause of the "burned grate," cause of clinkers, kind of coal to use, etc. Mention of illuminating gas and electricity as heating agencies should not be overlooked.

Demonstrate expansion and contraction with simple experiments—using water, air, mercury; and supplementing with allusions to such examples as railway rails, boiler explosions, cleaving ice, and the vacuum barometer. The fundamental tendency in all nature is to generate heat.

Outline:

1. Kind of heat:
   a, natural; b, artificial
2. Common sources:
   a, sun; b, artificial
   1, wood; 2, coal; 3, gas; 4, oil; 5, electricity
3. Common appliances
   a. open fire
   b. brick oven
   c. cooking range
   d. stove
   1, wood; 2, coal; 3, gas; 4, oil; 5, electric
   e. heaters, boilers, furnaces
4. Value
   a. in plant life
   b. in human life (physical)
5. Effects
   a, expansion; b, contraction; c, thermometer

C. Sanitation.

Introduction:—Commonplace topics like the following suggest a most interesting series of lessons. The real argument, however, for the general subject of sanitation is not in the response it may receive because of interest or entertainment but in the urgent necessity of teaching the subject in public schools. Community welfare is the stake.

On the one hand, knowledge of conditions that actually exist, and on the other, the *plain* duty of responsible citizenship, limit the scope of work necessary.

Outline:

1. Personal hygiene:
   a, exercise; b, pure food; c, fresh air
2. Community hygiene:
   a, fumigation; b, quarantine
3. Bacteria:
   a, sources; b, extermination; c, flies; d, milk; e, ice
4. Water supply:
   a, springs; b, wells; c, reservoirs
5. Sewerage:
   a, trap; b, disposal

6. Heating and Ventilation:
   a, steam; b, hot water; c, hot air; d, gas; c, electricity; f, temperature; g, humidity; h, fuel; i, thermostat
7. Diseases:
   a, small pox; b, scarlet fever; c, diphtheria

D. DRUGS.

Introduction:—The predominating aim here is to teach impressively the importance and advantage of a well defined and simple understanding of drugs. Proof experiments with commercial products will prove the best aid.

Outline:

1. Stimulants:
   a, tea; b, coffee; c, cocoa
2. Narcotics:
   a, alcohol; b, morphine; narcotine and cocaine; c, opium; d, chloroform; e, ether
3. Patent Medicine
4. Soothing Syrups
5. Headache Powders
6. Experiment (with small bottle and baby's nipple.)

E. ELECTRICITY.

Introduction:—The service rendered to mankind at the present time by electricity compels our attention every day. Its interesting history and its potential character demands our study. Its part in the drama of life is witnessed now by everyone every day. Surely it is difficult to imagine the human being so isolated that he does not produce or consume a product somewhere affected by this wonderful power.

The purpose of electricity in a general science course is

(1) to make a contribution of practical information to the child's knowledge
(2) to teach the principles of electricity by experience and personal observation
(3) to make the study fundamentally useful for its application and continuance
(4) to develop an inquisitive attitude

Outline:

1. History
   a, Thales; b, Franklin; c, Edison

2. Magnetism
   a, magnetic field; b, polarity; c, the earth a magnet; d, the magnetic needle
3. Forms
   a, lodestone; b, amber; c, silk paper; d, magnet; e, lightning
4. Electric current
   a, batteries; b, battery making; c, circuit; d, direction; e, heating affect; f, electric magnet; g, storage cells
5. Electrical circuits
   a, series; b, parallel; c, combination
6. Wiring cells
7. Methods of house wiring
   a, insulation; b, switches
8. Meters

F. SUPPLEMENTARY EXPERIMENT—FIRE EXTINGUISHER.

Introduction:—Factories, public auditoriums, and schools must by law be equipped with fire extinguishers. They must be placed near entrances, exits, and stairways, and also in boiler rooms.

An emergency may confront YOU. Knowledge of how to use the fire extinguisher may some time save life and property.

Constantly hold in mind during these experiments that *calmness* is absolutely necessary in an emergency.

Where should the extinguishers be located in this building?

1. *Demonstrate—(Underwriter's model.)*
   Preparations for a fire of paper, excelsior, of small wood should be made on the school lot. Take the extinguisher from its customary place, light the fire, and demonstrate.
   Dismantle the extinguisher by unscrewing the top, removing the head, and releasing the acid container. *Note the process carefully.* Note also the stopper device.
2. Recharge: 1st, fill tank with water up to water mark; 2nd, stir in ¾ pound of soda; 3rd, fill acid container with sulphuric acid, according to directions; 4th, replace acid bottle in carrier and securely fasten; 5th, screw in head; 6th, return to hook, ready for emergency.

G. SUPPLEMENTARY EXPERIMENT—PAINTING HOUSE SCREENS.

Introduction:—With a few simple directions and specifications for materials, boys of this age will be able to get satisfactory results in fixing up the screens at home.

This work would be done more often and consequently prolong the life of the screens if boys knew how to do it. This is another place for boys to become efficient cooperators with their fathers.

Outline:

1. Kinds
   a, copper; b, steel; c, frames (steel, wooden)
2. Season for painting
3. Paint: (for mesh; for frame)
   a, advantages of good quality; b, asphaltum
4. Brushes
   a, 3″ for mesh; b, 1½″ for frame
5. Procedure
   a, repair; b, clean screens thoroughly; c. avoid a dusty room; d, apply thin coats to both sides

H. SUPPLEMENTARY EXPERIMENT—SETTING WINDOW GLASS.

Introduction:—The day should be planned so as to have several sashes brought to the class room. It is advisable to set a small pane first and moreover such a job is likely to be more easily obtained. The sash in a basement or cellar window should be sought. The teacher should demonstrate in the removal of *both* sashes from the conventional casing.

The class may work in groups of three or four.

Emphasize the advantage of accuracy in measurement, neatness with putty and paint, and care to avoid breakage.

Outline:

1. Measure for new light
   a. cut from broken light if possible
   b. glass-plate, rolled
2. Remove sash
3. Remove broken pane
   a. use wide chisel (1½″)
   b. avoid cutting wood of sash
   c. save zinc triangles
4. Set
   a. seal and set bed with film of putty
   b. fasten with triangles
   c. apply putty, avoiding *ripples*
5. Finish when dry or partially so
   a, with paint; b, by cleaning

Ten Lessons on Our Food Supply.

WILLIAM GOULD VINAL, THE RHODE ISLAND NORMAL SCHOOL.

The writer does not claim originality for any appreciable part of this article. Most of the mathematical facts were gathered by the class in general science,—high school graduates just entering the Normal School. The figures have not been verified and undoubtedly contain mistakes. It is simply written as being suggestive as to the method of teaching this extremely vital subject. All around us we hear discussions of the high cost of living. In our windows we are hanging cards to show that we are members of the United States Food Administration. What can the teachers of our public schools do in this great drive for the conservation of food? The following is a summary of the lessons taught.

LESSON 1. ORGANIZATION OF THE COURSE. At the first meeting of the class the pupils were given a mimeograph sheet telling the terms used in general science and their meaning. Most of these terms and definitions were taken, with some modification, from the General Science Bulletin of the Massachusetts Committee. A few new terms were added. When the class understood the terms they were asked to read the notes on the selection of a general unit and prepare to vote by ballot for the one that they considered most worth while. The vote was almost unanimous for *Our Food Supply*. The following is a copy of the mimeograph sheet:

A. DEFINITIONS OF TERMS.

Education is the preparation for life.

General Science is learning those things in the natural environment which best fits one to meet those problems in life.

A *project* is an organized undertaking to solve some problem. Projects are of two kinds according to their needs:

Individual projects are based upon the definite need or desire of a pupil. (Desk light, electric bell, leakage of gas).

Community projects are based upon the definite need or desire of a group of individuals. (Sewerage disposal, municipal baths, prevention of infantile paralysis).

Projects are of two kinds according to the methods of meeting these needs:

Construction projects are those in which the student or group of students is making or assembling the parts of some mechanical device. (Making a wireless outfit or loaf of bread).

Interpretation Projects are those in which the individual or group of individuals observes or reads to interpret some question or problem. (How the wireless works or the action of yeast).

An experiment is an exercise performed by a pupil to obtain the answer to a problem met in a project.

A *demonstration* is an exercise performed by a pupil or teacher before a class to make clear some fact or principle met in a project.

A *general unit* is a main topic to be developed by projects, experiments, demonstrations, and discussion. (Food, water-supply, fuel, lighting).

A *topic* is usually limited to one subject which is related to a general unit. (General unit, fuel; topics, gas, alcohol, coal, petroleum, safety matches).

The *scientific method* is to make observations from which one may draw a conclusion.

B. SELECTION OF A GENERAL UNIT.

In selecting a general unit one should keep in mind that it must be (1) worth while, (2) interesting, (3) possible to make observations and do extensive reading, (4) a problem of this locality. The class may select the general unit which they think most interesting and most worth while at this time. Three to six weeks will be spent upon that unit and then another general unit will be selected.

Cleansing and dyeing	Street lighting
Our food supply	Home lighting
Household chemicals	Heat in the home
Baking powders and sodas	Our water supply
Metals used in the homes	Sanitation
Household electrical devices	Ventilation
Uses of electricity in the city	Photography
Building our houses	

LESSON 2. COMMUNITY PROJECTS IN FOOD CONSERVATION.

The needs of a community may become the needs of a nation or of the world and conversely the needs of the world become the needs

of every community. Not only to make the world safe for democracy but to make democracy safe for the world or for the community the individuals who make up the group should have intelligence as to their responsibilities. As food is the deciding factor of this war the students of the country should become acquainted with the food situation. Fully understanding this the members of the class were asked to make an outline of Lesson 1, in the pamphlet entitled "TEN LESSONS ON FOOD CONSERVATION" published by the United States Food Administration. The following outline was worked out by class discussion and then they were expected to finish it outside of class.

1. *Aims of Course.*
   (1). Acquaintance with world situation.
   (2). Definite and immediate things to do.
   (3). To carry out suggestions.
2. *Causes of Universal Shortage of Food.*
   (1). *Unkindness of nature.*
      a. Late springs. d. Poor conditions of rainfall.
      b. Droughts. e. Unexpected frosts.
      c. Hurricanes. f. Periods of intense heat.
   (2). Reduced productivity of soil in Europe.
      a. Bad management. 1. Withdrawal of men from farms. 2. Overworked women.
      b. Unskilled work. 3. Unskilled old men. 4. Listless prisoners.
      c. Lack of fertilizers—sunk by submarines.
3. *Conditions in Germany.*
   (1). Fats.
      a. No food is fried.
      b. Soap a luxury.
      c. Candles have disappeared.
   (2). Why Germany has power to endure.
      a. Four-fifths self supporting before the war.
      b. A nation given to overeating—reduction a benefit.
      c. Cultivating Belgium, Northern France, Roumania.
      d. Intricate food organization.
4. *Position of Allies.*
   (1). Dependent, even in peace, on importations.
   (2). Cannot get supplies from Central Europe.
   (3). Russia—disorganized railroads.

(4). India and Australia.
  a. Shortage of tonnage.
  b. Long distance.
(5). South America—general crop depression.
(6). United States
  a. Greatest food-producing country.
  b. Large acreage in crops.

LESSON 3. LOCAL COMMUNITY PROJECTS.

The study of the plan of the United States Food Administration led to the question: What is being done in Providence to meet the food situation? The class was able to give quite a list of local activities, as—

Canning Demonstrations by the Housewives League at the Arnold Biological Laboratory, Brown University.
Food Exhibit, Roger Williams Park Museum.
Home Gardens. Prizes offered by the Chamber of Commerce.
Faculty Garden of Brown University.
Cooking Demonstrations at R. L. Rose Company.
Freight Embargoes.
Etc.

The projects were listed on the board and the class told to sign their name opposite the one which they wished to investigate. No two were allowed to take the same project.

LESSON 4. THE FUNDAMENTALS OF AN ADEQUATE DIET.

A knowledge of the fundamentals of an adequate diet also becomes a community project at this time. Members of the class were thus asked to make an outline of Lesson IX in the pamphlet mentioned above. An examination was given upon these two summaries.

LESSON 5. THE COST OF BREAKFAST.

This meal was chosen as it is simpler and has a smaller range of variation. This becomes an individual project. In order to standardize results for comparison the following table was presented as a basis.

The pupils were asked to tabulate what they had for breakfast for several days, including the cost, the calories (energy value), and the proteid in grammes (tissue builders). From this data they figured the results for their average breakfast.

Food	*Average Weight*	*(Sept. 28, 1917) Price*	*Calories*	*Protein in Grams*
Oatmeal	**1/4 oz.**	**$0.00094 (6c lb.)**	**28.1.**	**1.08**
Corn Flakes	**1/2 oz.**	**.00625 (10c 8 oz.)**	**51.0**	**1.25**
Banana	**3 1/4 oz.**	**.02500 (30c doz.)**	**52.8**	**0.83**
Milk	**1 glass**	**.03000**	**182.5**	**8.25**
	for cereal	**.01500**	**76.0**	**3.43**
	for coffee	**.00300 (12c qt.)**	**15.2**	**0.68**
Coffee	**9 grams per cup**	**.02500 (40c lb.)**	**00.0**	**0.00**
Sugar	**heaping teaspoonful**	**.001716 (10c lb.)**	**30.0**	**0.00**
Slice White Bread	**1 oz.**	**.00833 (15c 1 lb. 2 oz.)**	**75.0**	**1.86**
1 pat butter	**1/4 oz.**	**.00750 (48c lb.)**	**50.0**	
1 medium potato	**3 oz.**	**.01000 (43c pk.)**	**55.3**	**0.79**
1 egg	**2 oz.**	**.06000 (72c doz.)**	**93.0**	**8.75**
Bacon, 1 slice	**28 grams**	**.02292 (42c. lb.)**	**75.9**	**2.55**

LESSON 6. A COMPARISON OF THE COST OF BREAKFAST FOR THE DIFFERENT MEMBERS OF THE CLASS.

The investigations of the class in Lesson 5 were now tabulated on the blackboard. Care was taken not to associate names with the cost of the meal, etc., so as to obtain free discussion. A few examples are given:

Student	*Cost*	*Calories*	*Protein*
A	**30c**	**975**	**30 grams**
B	**19.9c**	**411**	**20 "**
C	**12.5c**	**450**	**9.81 "**
D	**12.0c**	**787**	**18.36 "**
G	**4.8c**	**167**	**18.35 "**

General conclusion were derived from the table, such as:—

(1). The price paid for food must not be measured solely in dollars and cents.

(2). Thought and study is needed in planning the dietary.

(3). We need to find what foods will supply the most energy, and the various materials for repairing and building the body at the least cost.

Interpretation projects arose, such as:—

(1). What is the daily food requirement?

(2). What food habits can we change?

(3). What is the cheapest source for our food essentials?

LESSON 7. SOME OF THE REPORTS ON INDIVIDUAL PROJECTS. These developed out of the class discussion in Lesson 6.

(1). *Standard Amounts of Different Nutritive Constituents Required Daily* (Hutchinson, Food and Dietetics).

Protein 125 grams .... 512.5 calories.
Carbohydrate 500 grams ....2050.0 calories.
Fat 50 grams .... 465.0 calories.

Total 3027.5 calories.

Discussion of rations for children, normal school girls, athletes.

(2). *Table for Estimating the Comparative Cost and Food Value of Fish.* Student visited the Public Market to obtain the prices and studied textbooks for other data. A few of the significant facts reported are given:

Food as Purchased	*Refuse Per ct.*	*Protein Per ct.*	*Calorific Value*	*Market Price*	*Real Cost*
Cod, whole, dressed	**29.9**	**11.1**	**220**	**10c lb.**	**13c lb.**
Cod, salt	**24.9**	**16.9**	**325**	**13c lb.**	**15.5c lb.**
Herring	**?**	**11.5**	**825**	**8c apiece (3/4 to 1/2 lb.)**	
Mackerel	**44.7**	**10.2**	**370**	**18c. apiece (about 1 lb.)**	**27c lb.**
Halibut	**17.7**	**15.3**	**475**	**28c lb.**	**33c lb.**
Salmon, canned	**00.0**	**21.8**	**915**	**19c lb.**	**19c lb.**
Salmon, fresh	**40.**	**21.8**	**915**	**25c lb.**	**35c lb.**

Some conclusions:

(1). Whole fish, not dressed, are high priced due to the refuse.

(2). The market price is not the real cost.

(3). Herring is a cheap source of energy and protein.

A few interpretation projects that arose.

(1). What use can be made of fish refuse for food?

(2). May fish be used as a substitute for meat?

(3). *Table for estimating the Comparative Cost and Food Value of Meat.*

Food as Purchased	*Refuse Per ct.*	*Protein Per ct.*	*Calorific Value*	*Market Price*	*Real Cost*
Chicken	**41.6**	**58.1**	**295**	**35-40c lb.**	**56c lb.**
Fowl	**25.9**	**62.1**	**775**	**32-36c lb.**	**45c lb.**
Sirloin	**12.8**	**74.8**	**985**	**48-50c lb.**	**56c lb.**
Frankfurts	**00.0**	**88.9**	**1170**	**28c lb.**	**28c lb.**
Corned Beef	**21.4**	**65.3**	**1085**	**26-28c lb.**	**31-33c lb.**

Conclusions:

(1). Should consider the proportion of edible material when purchasing meat.

(2). Some cheaper kinds are just as nutritious and often less wasteful.

(3). A given amount of money will purchase about seven times the energy in corn beef that it will in chicken.

Interpretations:

(1). Why is the food value of chicken so low and the cost so high compared with fowl?

(2). How may cheaper meats be made palatable?

(4). *Comparison of Prices in the Local Produce Market and the Retail Markets.* Two students visited the farmers' wholesale market on Promenade Street and the retail markets. Results were tabulated on the board, as follows:

Local Produce Vegetable	*Market Price*	*Retail Market Price*	*Large quantities at the same rate*
Apples	$1.50-2.75 bu.	13c qt.	$4.16 bu.
Shelled Beans	$1.75-2.25 bu.	25c ½ pk.	$2.40 bu.
Pears	$1.50 bu.	22c qt.	$7.04 bu.
Tomatoes	$0.75-$1.75 bu.	10c qt.	$3.20 bu.

Conclusions; such as,—In the case of pears the same amount of money will purchase about five times as much in the wholesale market as in the retail.

(5.) *The Cost of Cereal.* Facts tabulated as follows:

Name of Cereal	*Weight per package*	*Price*
Corn Flakes	8 ounces	10c
Force	10 "	10c
Shredded Wheat	12 "	11c
Grape Nuts	14 "	13c
Oatmeal	1 lb. in bulk	6c
Cornmeal	1 lb. in bulk	6c

Conclusions:

(1.) Ready to-eat cereal foods are more expensive.

(2.) Crackers and milk give more nourishment for the same money.

(3.) Cereals are one of the cheapest energy builders.

LESSON 8. NEW FOODS AND METHODS.

A list of supplementary foods and methods were placed on the board, as—soy beans, cow peas, cottage cheese, home-ground wheat in the coffee grinder for a cereal, skim milk, black mussel, dogfish,

puffballs, wrapping green tomatoes in paper for winter use, putting eggs in water glass, drying fruits, preserving greens with salt, cold pack method, cotton seed flour, potato flour, rye bread, etc. Some of these, as canning, were demonstrated. Others might be classed as construction projects, as the making of cottage cheese which is said to have as much protein in one pound as is found in a pound and a half of fowl. The use of soy beans might be an experiment. They are richer and cheaper than other varieties but are not so palatable. Each pupil was asked to select one as an individual project and report to the class.

LESSON 9. A WAR BREAKFAST.

The individuals were now supposed to know the war situation in regard to our food supply. They had figured out the daily cost of breakfast. They had gained some knowledge as to the purchasing of foods, and as to the planning of meals that are fundamentally right. They were now asked to plan a war breakfast and compare the data with what they had tabulated for the fifth lesson.

The following was one of the best records. It was not only planned but carried out.

	Price	Calories	Protein
Ordinary Breakfast	20c	461.2	21.0 grams
War Breakfast	10c	1046.8	5.2 grams

Another wrote: "I used bananas on my shredded wheat instead of sugar and used Challenge Condensed Milk in my coffee for the same reason. I had corn muffins instead of wheat bread. I have not used fresh bread in any meal. In this one I have made use of stale bread in a bread pudding."

LESSON 10. ORGANIZING THE SCHOOL INTO A WORKING UNIT.

This consists of morning talks of about five minutes before the school in the assembly hall. The first talk was by the psychology teacher about "Food Ruts". These talks were on such subjects as, *The Black Mussel.* The black mussel is seldom eaten except by our foreign population. It is more nourishing, cheaper, and more easily digested than the oyster. Volunteers were asked to pledge themselves to support a mussel menu and the shellfish was served in the school lunch room the following day. It is hoped that each object lesson is later carried out in the homes.

The Story of Nitrates in the War. Ten Lessons.

W. G. Whitman, Normal School, Salem, Mass.

The present war influences our thought and action to such an extent that no wide awake teacher can fail to use some class material which relates more or less to this great world conflict. Among the many vital necessities for carrying on the war, none is more important than the nitrates.

Many facts and principles, related to the nitrates, their production and use are sufficiently simple for seventh and eighth grade pupils. The subject also lends itself to such treatment as will meet the capacities of high school pupils. It is suggested that pupils have a note book in which they record the more important facts and in which they write up the experiments which may be performed as demonstrations. This article is intended to give little more than an outline to suggest some material that may be used in class work. Even if the pupils do not go very deeply into the underlying science, it is possible for them to gain a better appreciation of some of the applications of science to meet the greatest demands the world has ever known.

Lesson 1. Nitrates. Natural Source. Oxidizing Agent. Show speciments of sodium nitrate, potassium nitrate and nitric acid.

Have pupils heard of saltpeter? Chile saltpeter? Discuss deposits of Chile saltpeter. Location. Mining. Purification; formerly sea water was distilled and used, but now pure water is brought from the more distant mountains. Why go so far for water? Why have the deposits been preserved so many years? Exports. Effect of the war upon the industry?

Experiment. Heat sodium nitrate in a test tube and show that it gives off a gas which causes a glowing taper to burst into flame. This gas is oxygen. Potassium nitrate also gives up oxygen when it is heated. Importance of this?

Lesson II. Gunpowder. Show four bottles. The first contains 75 grams powdered potassium nitrate; the second, 13 grams powdered carbon; the third, 12 grams powdered sulphur; and the fourth, a mixture of these three substances in the portions given

above. What experiences and knowledge of gunpowder can the pupils give? What uses?

Experiment. Ignite a teaspoonful of the home made powder taken from bottle four in an iron pan. The carbon burns. The nitrate furnished oxygen for burning. The sulphur combined with the potassium and made the smoke. What objections to a smoke producing powder? Why was there no loud report when the powder burned? What if it had been confined? How are Fourth of July fire-crackers and torpedoes made. How is commercial gunpowder made? Danger. Precaution taken. Forms of powder?

(Optional. Burn a piece of "touch paper" which is held in forceps, this illustrates the burning of a fuse. Touch paper is made by soaking filter or unglazed paper in a solution of potassium nitrate and then drying it).

LESSON III. EXPLANATION OF AN EXPLOSION. The molecules of gases are always in motion. The molecules of air in a room are incessantly striking the walls and all surfaces. Pressure results from the blows of the millions of molecules.

Experiment 1. Here is a burned out incandescent lamp bulb. There is no air or other gas in it. The air of the room is held apart across this space of 2½ inches by the strength of the glass. The air is exerting about 100 lbs. pressure on each half of the glass globe. If the glass be broken the air will be permitted to come together. Break the bulb by striking it a blow or dropping it upon the floor. Account for the loud report.

Experiment 2. Here is a pop-gun. Inside the barrel the air is exerting the same pressure as outside. Close with the cork. Press the piston in half way. If there is no leakage, the original air has been compressed into one half the space. There are now twice as many molecules pounding on a square inch surface and consequently there is double the pressure. By continuing to push on the piston the pressure inside continues to increase until suddenly the cork flies out with a loud noise.

Experiment 3. Place a candle bomb[1] (½") on a wire gauze on a tripod. Cover it well with another piece of wire gauze. (It should be placed at some distance from the pupils, at least 5 ft.). Place an alcohol flame or low gas flame under the bomb. While the bomb is being heated explain how water upon boiling changes

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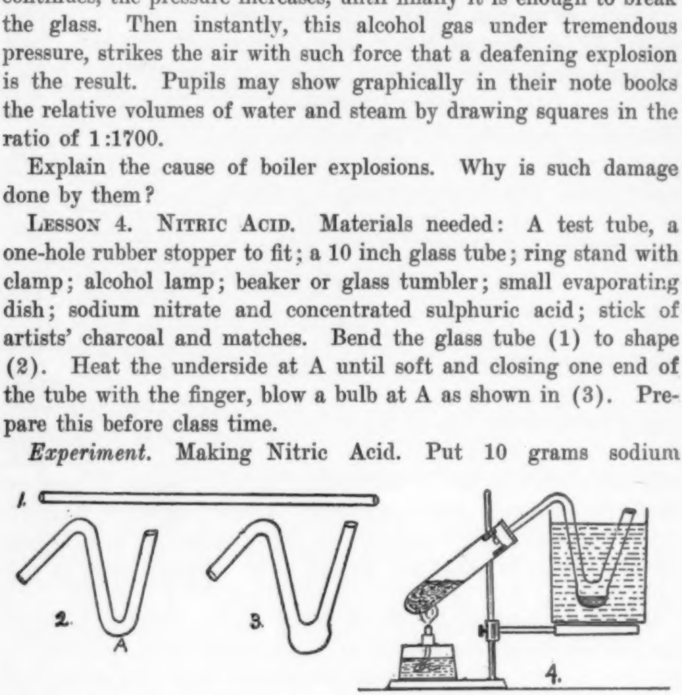
[1]Candle bombs can be obtained from any apparatus dealer.

in volume. One cubic inch of water makes 1700 cu. in. of gas (steam). The candle bomb contains alochol which has a lower boiling temperature than water. As the alcohol is heated, more and more of it changes to a gas, but the gas space in the bomb is very small, so the gas there must be under great pressure. As heat continues, the pressure increases, until finally it is enough to break the glass. Then instantly, this alcohol gas under tremendous pressure, strikes the air with such force that a deafening explosion is the result. Pupils may show graphically in their note books the relative volumes of water and steam by drawing squares in the ratio of 1:1700.

Explain the cause of boiler explosions. Why is such damage done by them?

LESSON 4. NITRIC ACID. Materials needed: A test tube, a one-hole rubber stopper to fit; a 10 inch glass tube; ring stand with clamp; alcohol lamp; beaker or glass tumbler; small evaporating dish; sodium nitrate and concentrated sulphuric acid; stick of artists' charcoal and matches. Bend the glass tube (1) to shape (2). Heat the underside at A until soft and closing one end of the tube with the finger, blow a bulb at A as shown in (3). Prepare this before class time.

Experiment. Making Nitric Acid. Put 10 grams sodium



nitrate into a test tube. Add enough sulphuric acid to barely cover the nitrate. Arrange apparatus as in drawing. Surround the bulb of the delivery tube with cold water in the beaker. Heat the mixture in the test tube, slowly at first, but later strongly enough to produce moderate bubbling. When the bulb is nearly full of nitric acid stop heating. Discuss the experiment. Cause of the bubbling in the test tube? Why cold water is used in the beaker? Source of liquid in the bulb? Show pure nitric acid (colorless). Color of acid made due to a colored gas produced by high temperature in test tube.

Experiment. Oxidizing property. Pour the acid made into the evaporating dish. Heat one end of the slender stick of charcoal until it glows. Thrust the glowing end into the nitric acid. Let pupils tell reason for the active burning. Nitrates have the same stored oxygen as nitric acid. This helps the pupil to understand how gunpowder can burn even though it is confined without air.

LESSON 5. HIGH EXPLOSIVES. Show five bottles which contain: (1), nitric acid; (2), sulphuric acid; (3), glycerine; (4), absorbent cotton; (5), tar or coal. These bottles contain the materials needed in making some of our most powerful explosives. Millions of pounds of high explosives are being used a day in siege guns, artillery, mines and bombs. Projectiles are hurled for many miles. Glycerin, nitric acid and sulphuric acid when properly treated, produce the liquid, nitroglycerin. This is rather dangerous even with ordinary care. Dynamite contains nitroglycerin, but is safer. Why? Uses of nitroglycerin? Dynamite? Use of explosives in farming? Shooting on oil well.

Cotton, nitric acid and sulphuric acid, when properly treated, produce nitrocellulose. There are different forms of this. The more highly nitrated products make the violent explosive guncotton which is the base of many smokeless powders. Nitrocellulose containing less of the nitrate is used in making collodion and celluloid. Make a list of the articles at home made in part or wholly of celluloid. Why are celluloid articles sources of danger?

Experiment. Hold a piece of moving picture film or celluloid comb in a pair of tongs and set fire to it. Explain cause of the rapid burning.

When coal is "distilled" in producing coke or illuminating gas, tar is a byproduct. When tar is distilled, one of the products is an oily liquid, toluol. Toluol is nitrified and tri-nitro-toluol, called T. N. T. for short, results. Tri-nitro-toluol is one of the most powerful explosives known and is far safer to transport and to use than nitroglycerin. It is extensively used in siege guns, depth bombs for submarines, torpedoes, etc.

LESSON 6. THE ARMY RIFLE CARTRIDGE. This lesson is based on an exhibit which may be prepared as follows: Secure a clip of five army rifle cartridges. Remove the bullet from two of these. This is done by securing the cartridge in a vice and gripping the bullet with a pair of pliers; work it loose. Pour the powder from one of the shells into a small pill vial just the size to hold it. Remove

the priming cap from one of the shells. This may be done by pushing the small end of a file into the little hole so that it touches the priming cap, then rest the cartridge on a bolt nut with the priming cap over the hole. Hold the file with pliers and drive it down with a hammer. A light blow is sufficient. With hack saw or file cut longitudinally through the outer metal of one of the bullets removed from the cartridge. Cut off some of the lead inside. File through the outer metal of another bullet which is in a loaded cartridge, so that a metal cap can be removed exposing the lead for a third to half an inch from the end.

Mount the exhibit on a piece of cardboard by wiring the individual pieces to it. The following pieces are suggested.

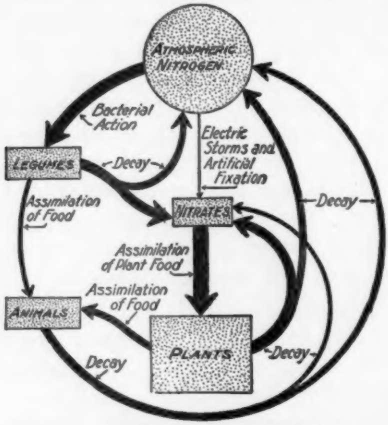
1. The bottle of powder. Exact content of one cartridge.
2. The brass shell with primer removed.
3. The priming cap. This may be glued to the cardboard.
4. The shell with priming cap in place.
5. The bullet.
6. The loaded cartridge complete.
7. The longitudinal sections of bullet, showing harder metal coating.
8. Complete cartridge, but with top of hard metal removed from the bullet. Make a hole in the metal tip and fasten it to the card.
9. The clip which holds the five cartridge, ready for loading the rifle.

Discuss shapes and forms of powder grains. Show pictures. Detonating caps and their use. Distance bullets travel; speed; rifle sights. Compare present bullets with those of Civil war. Dumdum bullets. At 2,000 ft. per second the friction of the air warms the uncapped lead until it is so soft that upon striking a hard body as a bone it will flatten and spatter, making an ugly internal wound.

LESSON 7. FROM NITRATES TO FOODS. One essential food material is that which contains nitrogen. Proteins are tissue builders; they repair worn out tissue. Nitrogenous foods or proteins are in lean meat and various plant foods. Make a list of such foods. Animals which supply the meat got the nitrogen from plants. Plants get nitrogen from the soil. If we remove plant crops year after year and do not return to the soil the things they have taken from the soil, we shall have poor crops.

Nitrogen must be returned to the soil. Commercial fertilizers:

compounds of nitrogen used. Other sources of nitrates besides the deposits in Chile. Nature's way of supplying the soil with nitrogen from the air. Nitrifying bacteria. Denitrifying bacteria. Liming a sour soil to protect the nitrifying bacteria. Crops which



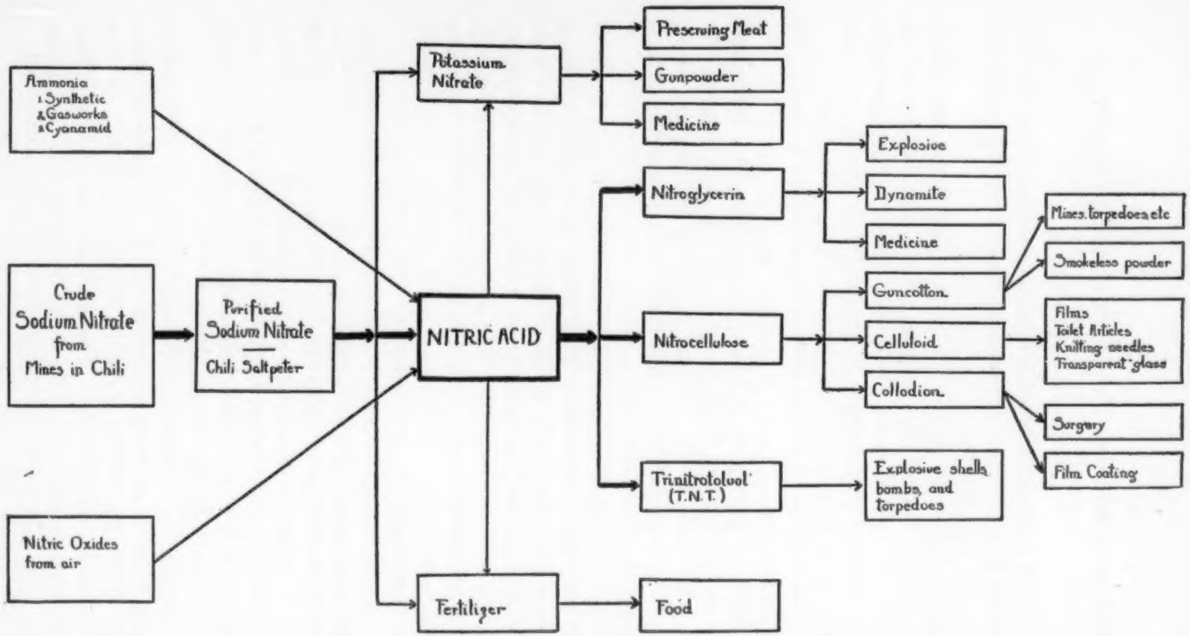
NITROGEN CYCLE *

favor development of nitrifying bacteria. Show pictures or drawings of legume roots with nodules. The cycle of nitrogen. Study the diagram and copy it into the note book. Is this natural process of supplying nitrogen to the soil adequate?

LESSON 8. PRODUCTS DERIVED FROM SODIUM NITRATE. Develop with the class an outline or diagram showing the various compounds and useful products dependent upon the use of nitrates. Pupils make the diagram in their note books. Explain how each of the products is of some value in the war.

LESSONS 9 AND 10. ARTIFICIAL FIXATION OF ATMOSPHERIC NITROGEN. With some classes it may seem advisable to continue the subject of nitrates to show how the United States could continue to make explosives and to provide fertilizer even though the supply of nitrate from Chile were cut off. Synthetic ammonia and its oxidation to nitric acid. Burning nitrogen in the oxygen of the air between terminals of electric arc. Cyanamid and other products. Some material on these topics is found in recent texts and chemical periodicals. Perhaps the best ready source is the pamphlet. "Cyanamid".

* This cut is from Blanchard and Wade's FOUNDATION OF CHEMISTRY. Copyright, 1914. American Book Company.



The Story of Nitrates in the War

Notes on Science Topics Related to the War.

Submarine Problems.

The Naval Consulting Board has issued its first bulletin on "The Submarine and Kindred Problems." The following notes are mainly from that report.

The latest submarine now in use has a surface speed of 17 knots, and a submerged speed of 10 knots. When near the surface the periscope can be raised, an observation taken and the periscope lowered inside of 30 seconds. When the submarine is on surface with uncovered hatches, it takes four minutes to submerge.

The Board is carrying three lines of investigation to combat the submarine menace.

1. *Means of discovering and locating an approaching submarine.* Aeroplanes are the best devise found so far for detecting the submarine when near shore. Sound recording devices are being tested, water is an excellent conductor of sound, and this field is promising.

2. *How to protect cargo ships.* Some use has been made of nets, guards, and screens, but their weight and cumbersomeness prevent easy handling of a vessel in maneuvering in heavy seas. None of these devises yet has the approval of the Navy Department. The best protection of a ship is its speed and maneuvering ability. Another protecting device is in the use of fuels for producing smokeless combustion. Submarines at a distance locate vessels only by smoke which is high in the air.

3. *How to destroy or blind a submarine.* The rapid fire gun has had some success in destroying submarines, but the Board has more faith in the use of heavy charges of high explosives set off deep in the water in the vicinity of the submarine. Such an explosion because of the incompressibility of water exerts such powerful pressure on all neighboring bodies that a submarine if within several hundred feet will be crushed.

The blinding of a submarine is accomplished by using heavy black petroleum which floats on the water. As the periscope passes through the surface of the water it is coated with an oily film which clouds the optical glass. The production of a smoke screen by burning phosphorus or coal tar or by the incomplete combustion

of fuel oil has at times made it possible for ships to escape. Nets have also been laid in which to catch submarines. Tidal action offers a difficulty which has not been entirely overcome in the use of nets.

Submarine bases cannot be destroyed because they are strongly protected by land batteries, aeroplanes, and mine fields.

AEROPLANE FLIGHT RECORDS.

Capt. Guilio Laurzami of the Italian Army recently flew from Turin to Naples and return without stopping, covering 920 miles in 10½ hours.

In June, 1916, Lieut. Antoine Marchal, a French aviator, flew from Nancy, France to Chelm, Russian Poland, a distance of 807 miles.

In November, 1916, Miss Ruth Law flew from Chicago to Hornell, N. Y., a distance of 590 miles. She did this in 5¾ hours. She holds the American long distance, non-stop record.

THE NITRATE INDUSTRY.

Of the world's trade in heavy chemicals, the compounds of nitrogen, nitrate of soda and ammonium sulphate take the lead, reaching as they do into the hundreds of millions of dollars in value. Seven hundred thousand tons of nitrate were used in one year in one smokeless powder plant in the United States. With such enormous need of nitrates, it is not safe at the present time for the United States to depend entirely upon a supply of nitrates from Chile.

There are three important methods for the fixation of atmospheric nitrogen: first in the synthesis of ammonia from nitrogen and hydrogen; second, the combustion of nitrogen in oxygen by the heat of the electric arc; and third, the combination of nitrogen with carbides or metals..

1. Nitrogen is obtained from liquid air and hydrogen is obtained from coal gas. These two are mixed and passed over iron wool—a catalizer—under two or three atmospheres of pressure at 500° C.; the product is ammonia. From the ammonia nitric acid is made by an oxidation process.

It is claimed that the Germans have so perfected this process since the beginning of the war that after the war, it will not be profitable to recover ammonia from gas liquor, because by this new process it can be produced at one-third the cost.

2. At 5500° F. nitrogen will burn in oxygen. When air is

passed between the terminals of an electric arc some of the nitrogen will form nitric oxide. When this gas is cooled to 1150° F. it combines with more oxygen forming nitrogen peroxide. When the peroxide is dissolved in water, nitric acid is formed, and if the peroxide is passed into lime water, calcium nitrate is formed. Calcium nitrate—called Norwegian saltpeter—is manufactured by this process in Norway where electric energy is obtained at low cost from water power.

The acid that is made is very weak. Some of it is concentrated, but more of it is made into Norwegian saltpeter to be used as a fertilizer, or into ammonium nitrate for use in explosives.

There are in the United States experimental plants using this arc process.

3. The United States has taken the lead in fixing atmospheric nitrogen by the use of carbides. A few years ago Professors Frank and Caro tried to produce cyanides by combining nitrogen with barium carbide. They also tried calcium carbide which was cheaper, but instead of making a cyanide they found that a new compound resulted which proved to be calcium cyanamide or lime nitrogen.

At Niagara Falls the American Cyanamide Company have a plant covering forty-two acres. They use water power for generating electricity for their electric furnaces and for power. They make a high grade carbide. The plant is on the Canadian side.

In the electric furnaces the lime and coke become liquid calcium carbide. Three or four times an hour the furnace is tapped and the carbide run off into iron cars where it solidifies. When the carbide is cold it is ground to a dust.

Air is liquified and from this pure nitrogen is obtained.

Four hundred and eighty electric furnaces are used for combining the carbide and nitrogen into calcium cyanamide.

$$CaC_2 + N_2 = Ca\ CN_2 + C.$$

When the cyanamide is treated with steam at high pressure, ammonia gas is given off:

$$CaCN_2 + 3H_2O = 2NH_3 + CaCO_3.$$

By passing the ammonia gas with oxygen slowly over finely divided platinum at 5750°F., nitric acid is made. This is the Ostwald process.

$$NH_3 + 4O = HNO_3 + H_2O.$$

This is the cheapest way to produce *pure* ammonia, and large quantities of it are now being used in making ammonia nitrate for explosives.

Lime nitrogen or calcium cyanamide may be used directly as a fertilizer but without proper preparation there is danger in so using it.

It should be partly hydrated to make sure there is no undecomposed carbide left. It should be made dustless by oiling and then mixed with other fertilizing ingredients.

The ammonia from the cyanamide may be changed to a sulphate, a nitrate, or a phosphate. When ammonium phosphate is mixed with potash salts, a complete fertilizer results, which is much more concentrated than the commercial fertilizer now on the market.

THE NEED OF NITRATES.

During one day of the Somme fighting, the artillery alone used fifteen million pounds of powder.

To make one pound of powder requires three pounds of nitric acid, which is equivalent to four and one half pounds of sodium nitrate. One powder company in the United States used in one year two hundred thousand tons of sodium nitrate.

Chile saltpeter is now our main source of nitrate. Congress has appropriated $20,000,000 for developing the industrial production of nitrates from atmospheric nitrogen. The committee having this in charge recommends that nitric acid be made by oxidation of ammonia, and it has planned to use one-fourth of the sum appropriated at once.

WHY NITROGLYCERIN IS A MORE POWERFUL EXPLOSIVE THAN GUNPOWDER.

When gunpowder explodes, the gas at ordinary conditions of temperature and pressure would occupy three hundred times the volume of the powder. When nitroglycerin explodes, the resulting gas under normal temperature and pressure would occupy twelve thousand times the volume of the nitroglycerin. In both cases, the high temperature at the instant of explosion tends to expand the gas to many times these volumes.

It would require tremendous pressure to hold this gas is a confined space. The larger the volume of gas, the greater the resulting pressure. While both these substances seem to explode instantly, the explosion of the nitroglycerin is much more rapid than that of

gunpowder. This is another reason for the greater force exerted when nitroglycerin explodes.

It is sometimes said that the effective force of nitroglycerin or dynamite, which contains nitroglycerin, is downward, while that of powder is upward. If dynamite and powder were each exploded on the surface of the earth, the dynamite would make a deeper hole in the earth. The comparatively slow rate of explosion of the gunpowder gives the liberated gas time to push away the air. The gases are liberated so rapidly when dynamite explodes that the overlying air cannot be moved away until force has been directed downward. The fact that a larger amount of gas is liberated also tends to produce greater force in all directions.

WHAT IS T. N. T? WHY IS THE SUPPLY LIMITED?

Tri-nitro-toluol, or tri-nitro-toluene, or T. N. T. is a white solid which is easily made and which is safer to use than many other explosives. Chemically it is $CH_3C_6H_2(NO_2)_3$ It is made from toluol and nitric acid. The toluol is obtained as a by-product in the coke industry. There is not enough toluol prepared in this country to supply its present needs. The tar and illuminating gas of the city gas-works contain toluol. By making certain changes in equipment the toluol could be saved. Toluol in gas gives illuminating power, but if gas mantles are used its absence will not be missed. It is of no value in the gas used for heat. It has been estimated that enough toluol is burned in illuminating gas in the United States in *one day,* to make T. N. T. for 150,000 3-inch shells. Three hundred pounds of T. N. T. are used in a single torpedo.

POTASH.

It is not ammunition alone that makes a winning army. Food makes the strength of an army. Commercial fertilizers play an important part in the food production of our country. The relative values of the three most important plant foods in commercial fertilizers in the United States is indicated by these figures.

Nitrogen $75,000,000.

Phosphoric acid $65,000,000.

Potash $35,000,000.

At the beginning of the war, Germany had the only ready source of potash, the Stassfurt deposits. Then, potash sold at $35 a ton. Since then, it has sold for $450 a ton. This accounts for the low percentage of potash found in our commercial fertilizers. The

United States is now getting a large amount of potash from sea kelp. It is estimated that there is enough potash in the large deposits of kelp at San Diego, California, to supply our country for agricultural purposes for many years.

A KELP FARM.

Along the coast of Santa Barbara County, California, the kelp grows in water out to a hundred foot depth. It reaches the surface and runs over the surface of the water. The Government is using sea mowing machines with which it cuts the kelp below the water surface and loads it upon a barge holding a hundred tons. Four crops of kelp can be harvested from one place in a year.

Each hundred tons of wet kelp gives ten tons of dry kelp. The dry kelp is dry distilled in retorts. The nitrogen which passes off is recovered in the form of ammonia. Ten tons of dry kelp yield two and one-half tons of potassium chloride. This is obtained by leaching the residue left in the retorts and evaporating off the water. Other products in this industry are combustible gas and iodine.

WATER POWER SAVES FUEL; FUEL HELPS WORLD DEMOCRACY.

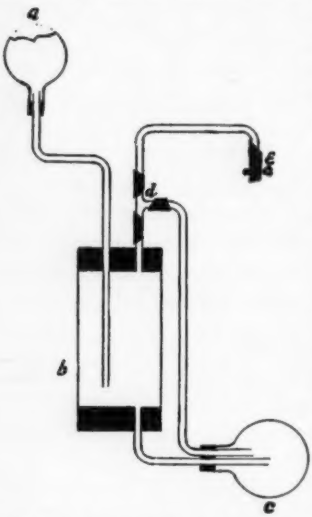
The Chicago, Milwaukee, and St. Paul Railroad is to be operated from Seattle to Harlowton, Montana, a distance of nearly 1,000 miles by electricity. The electric zone now completed is 450 miles in extent. The coal used in locomotives for this distance cost $1,750,000 a year and one-third of the equipment of the road was used to haul the coal. Under the electrified system the cost will be $550,000. No equipment is needed to haul the fuel and 200,000 tons of coal a year will be saved for other uses. The Missoula division formerly burned 425,000 barrels of oil a year. Electrification is now under way in the Cascades which will save 375,000 barrels of oil in addition.

The 200,000 tons of coal is enough to take a United States torpedo boat destroyer 2400 times around the British Isles, or it will supply forty-five destroyers with fuel for a year for active service searching for German submarines.

Hot Water Boiler: Demonstration Apparatus.

Otto J. Walrath, High School, Bloomfield, N. J.

For those teachers who desire to show the principle of the hot water boiler and the water-front in the kitchen range, the simple set of apparatus shown in the accompanying diagram may prove useful. It is easily put together and is comparatively inexpensive. For the boiler (b) I use a piece of hard one inch glass tubing about two and one-half or three inches long, with a two-hole rubber stopper at the top and a one-hole rubber stopper at the bottom. It is held in place by a clamp attached to a ring stand. (a) is a flask from which the bottom has been removed. It represents the city water system, and serves the double purpose of allowing the addition of water and of allowing expansion when the water is heated in (c). (a) rests in a ring clamped to the top of the same stand by which (b) is held. (c), of course represents the water front. It rests on a wire gauze on a ring held by another stand and is held in place by a test tube clamp attached to its neck. For the water pipes I use small glass tubing. At (d) I use a glass T which is fitted to the other glass tubing with rubber connections. At (e) I use a short piece of rubber tubing, on which I place a clamp so that water may be drawn off occasionally. In order to show the direction of flow of currents, the water placed in (c) may be colored.



New Books.

"An Elementary Study of Chemistry." By McPherson and Henderson. Ginn & Co.

The second revised edition of this popular book is ready. It is an attractive volume full of real chemistry, with an abundance of daily life and industrial applications.

"Every-day Physics." By John C. Packard. Ginn & Co.

This volume of 61 laboratory exercises is unique in providing an introduction to most of the exercises. This gives to the exercises the proper setting which is so often lacking. There are good diagrams. Many of the exercises are admirable for the general science laboratory.

"Experimental General Science." By W. N. Clute. Blakiston's Son & Co.

The author believes that the pupils ought to perform experiments with inexpensive apparatus. At the close of each chapter is a list of questions and suggestive experiments, but the book is so arranged that it can be used entirely for recitations if the teacher so desires.

303 pages. 96 illustrations.

General Science. By Charles H. Lake, Silver, Burdett & Co.

This book is just off the press and is a worthy contribution to the ever increasing number of general science tests. It was written with the needs of the pupils in the Junior High Schools in mind. 454 pages, 400 illustrations.

"Science Teaching." By George R. Twiss. The Macmillan Co. 486 pages. $1.40.

If you are able to add but *one* book to your science library this year, this is the book to add. It has a large amount of helpful suggestions to science teachers. It treats general science with moderation. It has something for science teachers of every kind and creed.

The book is prrticularly designed as a text for prospective teachers in normal schools and colleges.

Magazine Literature of Interest to Science Teachers.

Agricultural Digest. 2 W. 45 St., N. Y. Monthly. 15c a copy, $1.50 a year.

Good chart suggestions will be found in the MAY NUMBER, page 448 (*Soils*) and the OCTOBER NUMBER, page 663 (*Hygiene*). Articles and diagrams on *Storage of Vegetables* are in the SEPTEMBER and NOVEMBER NUMBERS. In the JUNE NUMBER are a number of interesting illustrations and notes on *"The Life of the Bee."*

Current Opinion. 65 W. 36 St., N. Y. Monthly. 25c a copy, $3.00 a year.

IN THE DECEMBER NUMBER is a short article on Moseley's *"Disclosure of a Secret of a New Atom"* and a description of the latest *German Biplane.*

The Electrical Experimenter. 233 Fulton St., N. Y. Monthly. 15c a copy. $1.50 a year.

THE NOVEMBER NUMBER has an interesting page of pictures of *"Historic Electrical Apparatus"*; Part III of *"The Marvels of Radio-Activity"*; and *"How Big Electrical Men Work"*, which

gives a glimpse of the daily work of De Forest, Pupin and Edison. THE DECEMBER NUMBER explains the transmission of pictures by telegraph. On page 563 is an interesting list of *discoveries "not made by Teutons."* Part IV of *"The Marvels of Radio-Activity"* concludes this series.

Everyday Engineering Magazine. 33 W. 42 St., N. Y. Monthly. 10c a copy, $1.00 a year.

OCTOBER NUMBER. A good article on *"Early Aeroplanes."* The Articles under department heading *"Everyday Aeronautics"* is continued in November and December numbers. *"Testing Milk."*

DECEMBER NUMBER. Illustrated article, *"The Caterpillar Tank, What It Is, How It Works." "Household Tests for Meat."*

Garden Magazine. Garden City, N. Y. Monthly. 25c a copy, $2.00 a year.

THE NOVEMBER NUMBER has a practical article on *Greenhouse Heating"* with illustrations of boilers which are exceptionally efficient. There are good sectional diagrams of the boilers and furnace. *"Getting the Garden under Glass"* is another article of particular interest to teachers who have charge of school gardens. There are some helpful suggestions in *"Can you Cook a Potato?"*

DECEMBER NUMBER. Those teachers interested in insect pests should read the article on *"Aphids"* by Miss Patch.

The Guide to Nature. Sound Beach, Conn. Monthly. 10c a copy, $1.00 a year.

Every issue of this popular magazine has a chart of the heavens for the current month and an excellent article about the stars by Professor Doolittle of the University of Pennsylvania.

Geographic Review. West 156 St., N. Y. Monthly. 50c a copy, $5.00 a year.

DECEMBER NUMBER. The leading article is an illustrated article on *"Flanders."* 17 pages. A brief account is given (p. 486) of *"A New Theory of the Origin of the Chilean Nitrate Deposits."*.

Illustrated World. Chicago. 15c a copy, $2.00 a year.

JANUARY NUMBER. *"Will you see a great eclipse?"* A four page illustrated article referring to the total eclipse of the sun on January 8, 1918.

Journal of the Franklin Institute. Philadelphia, Pa. Monthly. 50c a copy, $5.00 a year.

FEBRUARY NUMBER. *"Ceramic Industries in the United States."*

MARCH NUMBER. *"Production of Light by Animals"* (the fireflies.) This series of articles running through many numbers of the Journal is a revelation of the wonderful light producing power of a multitude of forms of animal life. The theory of light production is discussed.

AUGUST NUMBER. *"Physics of the Air,"* by W. J. Humphreys, U. S. Weather Bureau. Well illustrated. Teachers can read chapter one with profit. Chapters 2 to 4 are too technical. The

subject is continued in subsequent numbers; little of it is of value to teachers. *"Submarines in Periodical Literature"* is a digest of all the important articles in the last six years. It gives in 55 pages much valuable information about submarines and torpedoes.

SEPTEMBER NUMBER. *"Chemistry of Cellulose and its important Industrial Application."* An excellent article offering material suitable for chemistry and general science classes.

OCTOBER NUMBER. *"Development and Progress in Aviation Engines."* A good usable article, has illustrations of engines and different models of aeroplanes.

NOVEMBER NUMBER. *"Studies in Actinochemistry."* This will be continued in future numbers. It is somewhat technical, but on the whole very readable and offers much to high school science teachers.

The Literary Digest. 354 Fourth Ave., N. Y. Weekly. 10c a copy, $3.00 a year.

DECEMBER 15. *"Dishwashing and Disease." "Food in the Forest." "To Fight the Waste of Gasoline."* The last named article has a cut which shows graphically the quantities of gasoline consumed in its various uses.

The National Geographic Magazine. Washington, D. C. Monthly. 25c a copy, $2.50 a year.

THE AUGUST NUMBER contained *"Industry's Greatest Asset—Steel."* Because of its fund of vital scientific and geographical applications, it ought to be read by every high school pupil in the country. There is excellent class material in it. It is 36 pages in length and includes 34 illustrations.

THE OCTOBER NUMBER is *"Flag Number."* Nearly 1200 flags are shown in full colors. Here you may find every flag, pennant and banner in use during the last seven centuries, even showing the most recent flag of the Virgin Islands. The 32 pages of color are in four color work and cost $60,000 to print. This most ambitious achievement of periodical literature has taken two years in preparation and does great credit to the Geographic Magazine staff.

Popular Science Monthly. 239 Fourth Ave., N. Y. Monthly. 15c a copy, $1.50 a year.

THE DECEMBER NUMBER shows an interesting series of pictures illustrating how *serums and vaccines are made for U. S. Army.* The new *self-starting siphon* is explained with a diagram on page 832. In connection with the study of gravity the article *"Breaking the Chain that Binds us to Earth"* is valuable and extremely entertaining. Articles relative to the submarine problem are: *"The Unsinkable Submarine"* p. 840, *"The Smoke Screen* p. 854, *"Camouflage"* p. 876, *"Protecting Battleships with Compressed Air"* p. 886, *"The Submarine Net"* p. 915.

Useful Pamphlets

U. S. FOOD ADMINISTRATOR, Washington, D. C.
"Lessons in Community and National Life." Community Leaflets Nos. 2 and 5. (Section B). Lessons B1 and B5. 5c each; cheaper in quantity.

E. I. DU PONT DE NEMOURS AND CO., Wilmington, Delaware.
" High Explosives," "The Giant Laborer," "Hand Book of Explosives."

THE NAVAL CONSULTING BOARD, 13 Park Row, N. Y.
Buletin 1. *"The Submarine and Kindred Problems."*

AMERICAN CYANAMID COMPANY, 511 Fifth Ave., N. Y.
"Cyanamid."

CHICAGO, MILWAUKEE, AND ST. PAUL R. R., Chicago.
"The King of the Rails."

MOVING PICTURE FILMS.

THE AMERICAN CYANAMID CO. will loan a film showing the process of manufacturing cyanamid.

THE BARRETT MFG. CO., N. Y. has a film "From Coal to Corn," showing the process of making nitrate fertilizer from the gas liquor ammonia.

The following list of pamphlets, useful as supplementary material in science classes, is submitted by Mr. A. H. Morrison of the Boston Mechanics Arts High School:

Automatic Fire Protection — Gen. Fire Ext. Co., Prov., R. I.
The Tycos Hygrometer. The Barometer Book — Taylor Inst. Co., Rochester, N. Y.
Starrett Memorandum Book — L. S. Starrett Co., Athol, Mass.
Mechanics of the Sewing Machine — Singer Sew. Mach. Co., New York
Directions for Candle Power Determination — Nathaniel Tufts Meter Co., Boston, Mass.
Soldering Kinks — M. W. Dunton Co., Prov., R. I.
Humidity and the Humidostat — Johnson Service Co., 60 Pearl St., Boston
Table of Decimal Equivalents — Chandler & Farquhar Co., Boston
Instructions for the Installation of Copper-Hewitt Lamps — Cooper-Hewitt Electric Co., Hoboken, N. J.

A Chemistry Library for High Schools.

The following books may be bought for Fifty Dollars. They were selected by a committee of the New England Association of Chemistry Teachers. A Twenty-five Dollar list includes those starred (*).

***The Romance of Modern Chemistry.** *J. C. Phillip.* Lippincott.
***Triumphs and Wonders of Modern Chemistry.** *Martin.* Van Nostrand.
***The Chemistry of Commerce.** *R. K. Duncan.* Harpers.
***Chemistry in Daily Life.** *Lassar-Cohn.* Grevel.
***Chemistry of Familiar Things.** *S. S. Sadtler.* Lippincott.
***Chemistry of Common Things.** *Brownlee.* Allyn and Bacon.
***The Chemical History of a Candle.** *M. Faraday.* Harpers.
***The Story of Oil.** *W. S. Tower.* Appleton.
***Chemistry in the Home.** *H. T. Weed.* American Book.
***Pure Foods.** *J. C. Olsen.* Ginn.
***Clean Water and How to Get It.** *A. Hazen.* Wiley.
***Photography for Students of Physics and Chemistry.** *Derr.* Macmillan.
***Textiles.** *W. H. Dooley.* Heath.
***The Story of Iron and Steel.** *J. R. Smith.* Appleton.
***The Story of Gold.** *E. S. Meade.* Appleton.
***A Manual on Explosives.** *Ramsay and Weston.* Dutton.
***The Intepretation of Radium.** *F. Soddy.* Putnam's.
***Modern Science Reader.** *R. M. Bird.* Macmillan.
Modern Chemistry and Its Wonders. *Martin.* Van Nostrand.
Some Chemical Problems of Today. *R. K. Duncan.* Harpers.
The New Knowledge. *R. K. Duncan.* Barnes.
Source, Chemistry and Use of Food Products. *Bailey.* Blakiston.
Chemistry in America. *E. F. Smith.* Appleton.
The World's Minerals. *L. J. Spencer.* Stokes.
History of Chemistry. *F. P. Venable.* Heath.
Coal and the Coal Mines. *H. Greene.* Houghton Mifflin.
Textile Chemistry. *F. Dannerth.* Wiley.
Chemistry of Dyeing. *J. K. Wood.* Van Nostrand.
History of Chemistry. 2 vols. *E. Thorpe.* Putnam's.
Physical and Chemical Constants. *Kaye and Laby.* Longmans.
Chemistry in the Service of Man. *A. Findlay.* Longmans.
Chemistry and Its Borderland. *A. W. Stewart.* Longmans.
Laboratory Arts. *G. H. Woollatt.* Longmans.